REPLACEABLE CATHODE FOR ELECTRON BEAM GENERATING SYSTEM

Filed Dec. 13, 1966 9 Sheets-Sheet 1

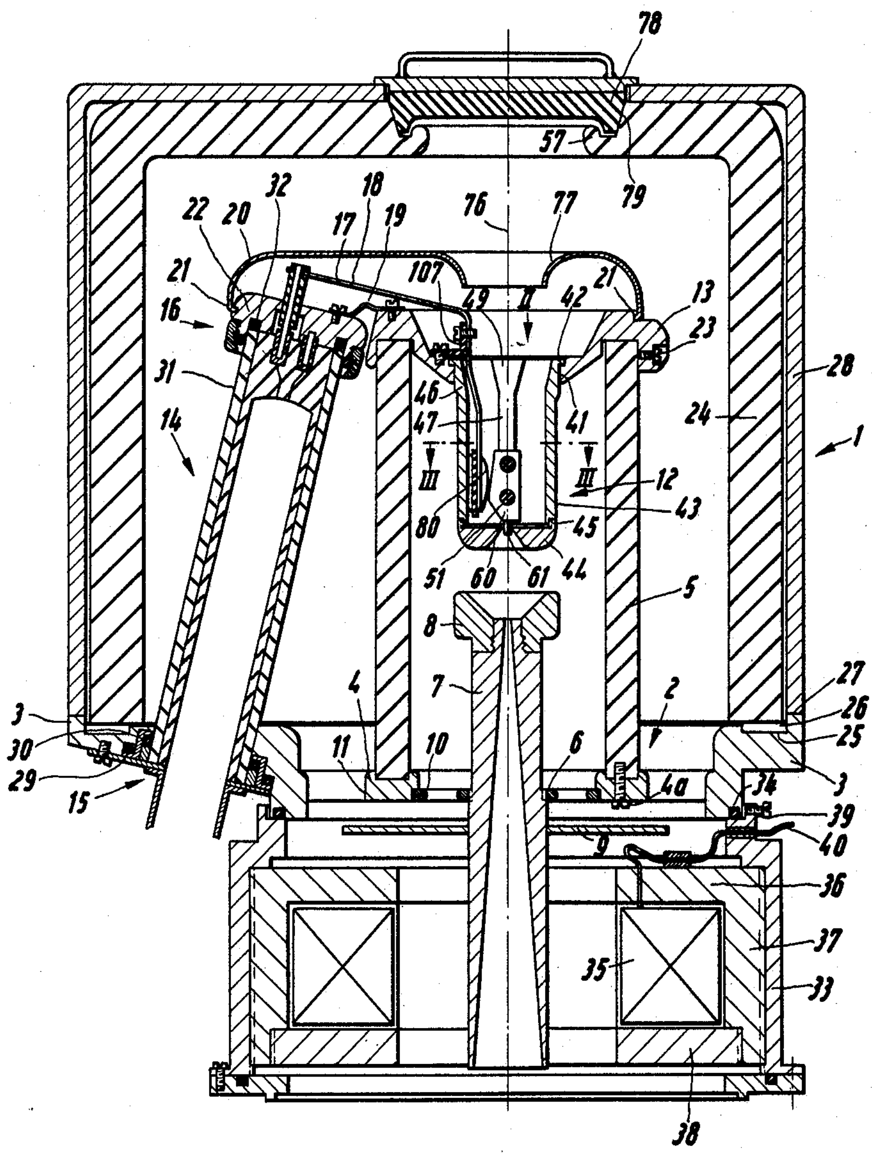

Fig. 1

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Fig. 2

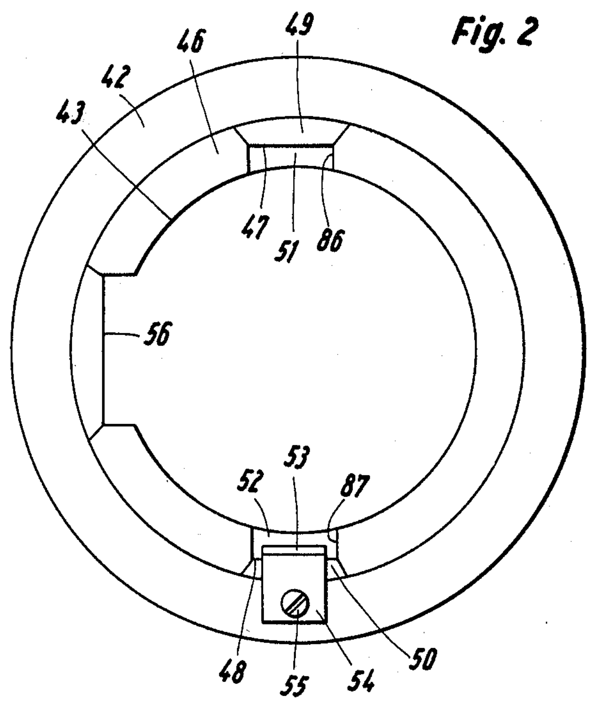

Fig. 3

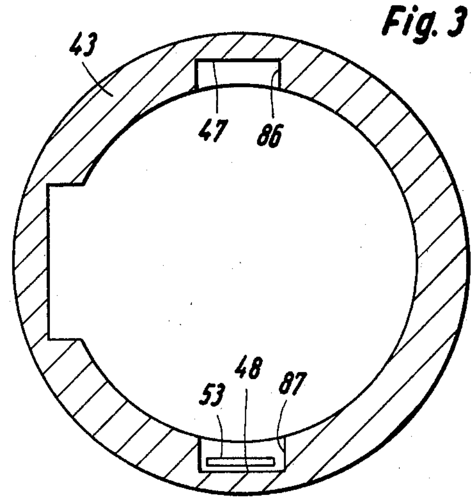

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Fig. 4

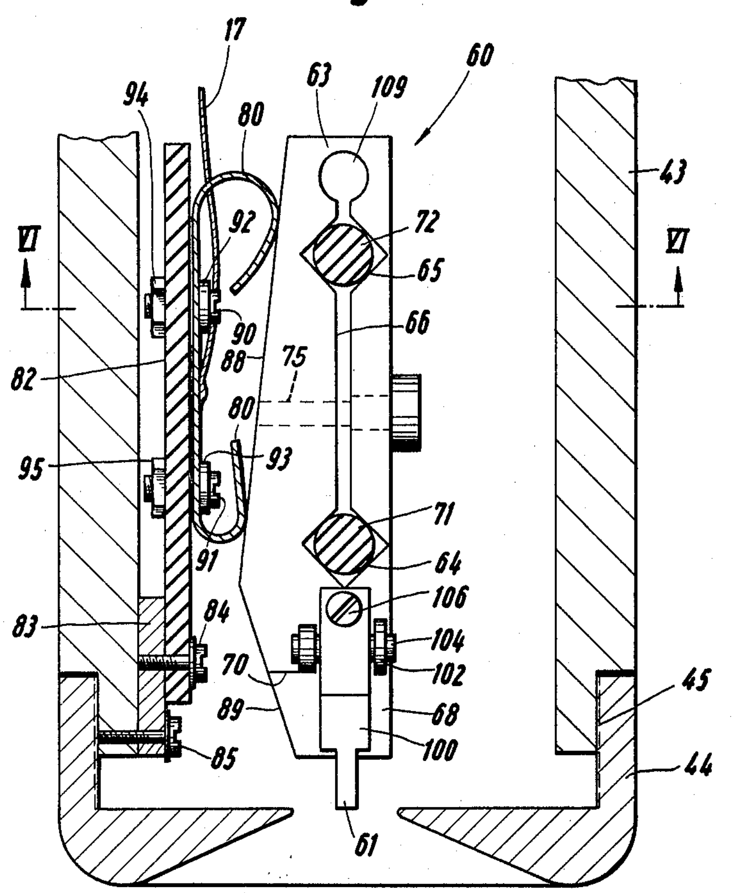

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Fig. 5

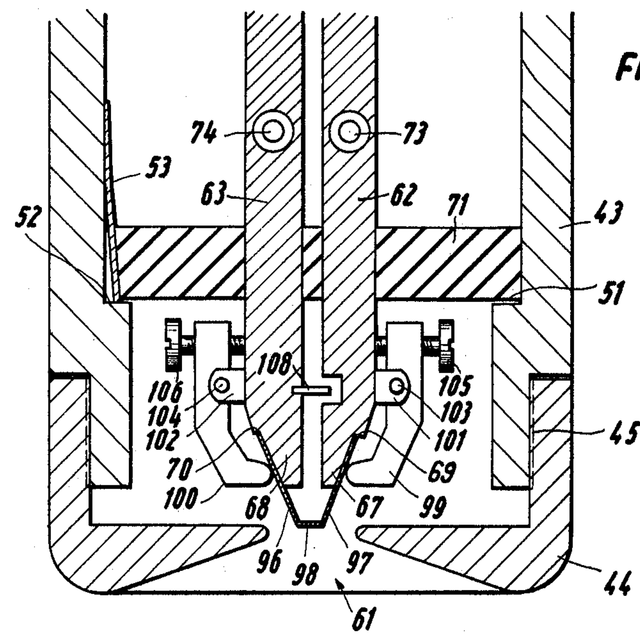
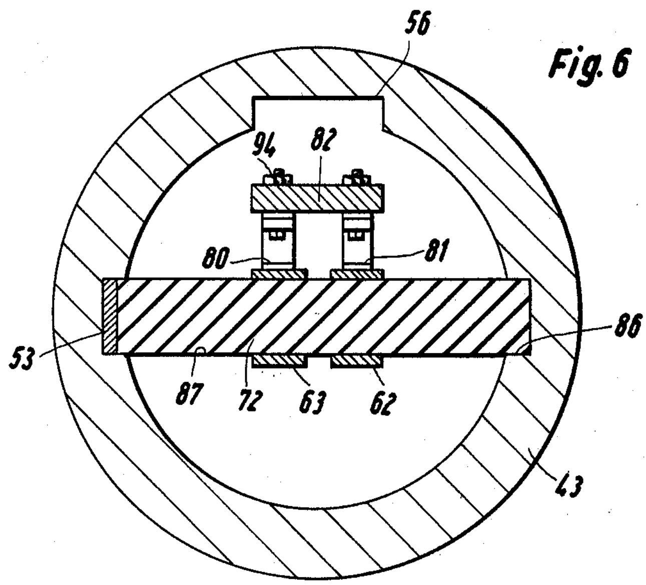


Fig. 6



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Nov. 11, 1969 E. MEYER ET AL 3,478,244

REPLACEABLE CATHODE FOR ELECTRON BEAM GENERATING SYSTEM

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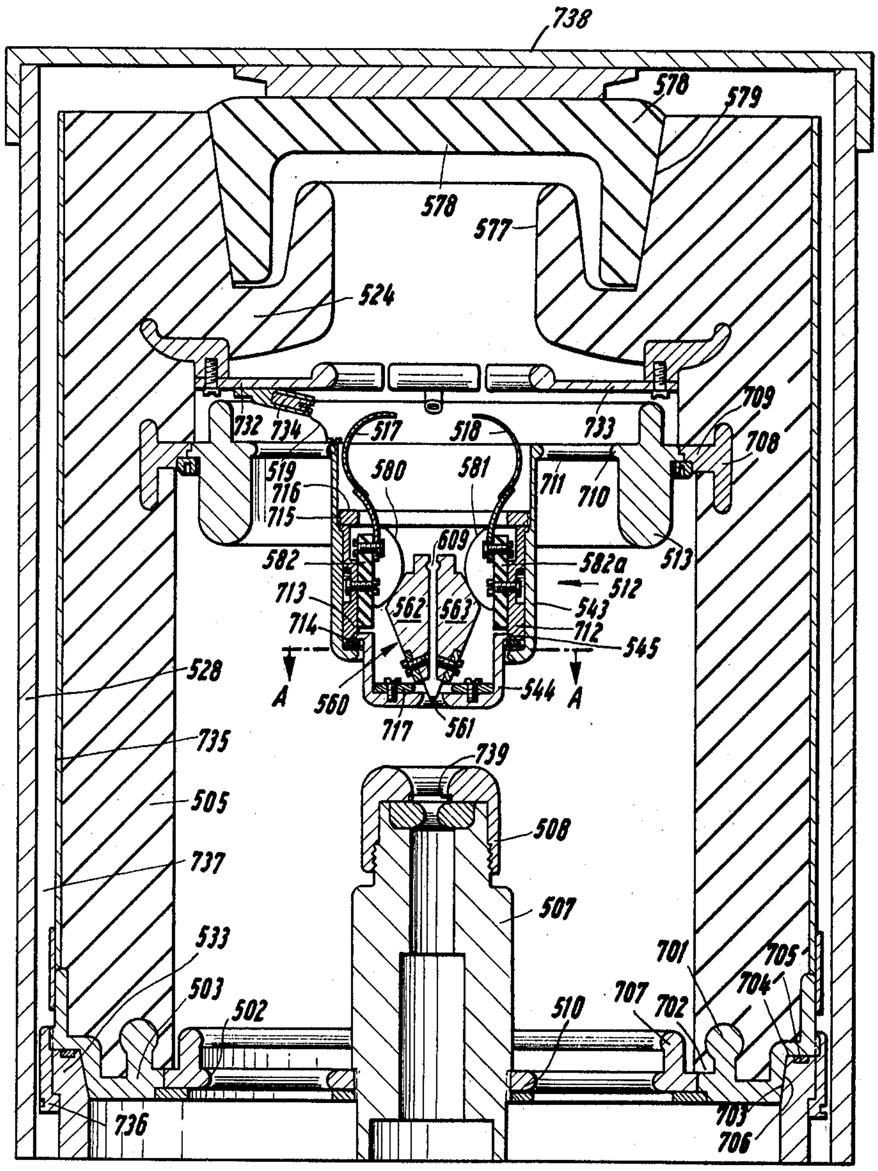

Fig. 7

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REPLACEABLE CATHODE FOR ELECTRON BEAM GENERATING SYSTEM

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Fig. 9

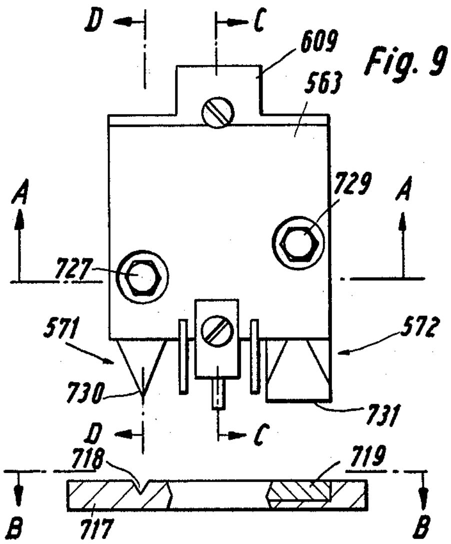


Fig. 10
(A - A)

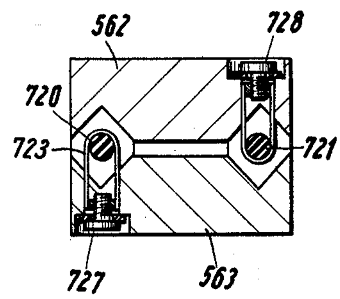


Fig. 12
(B - B)

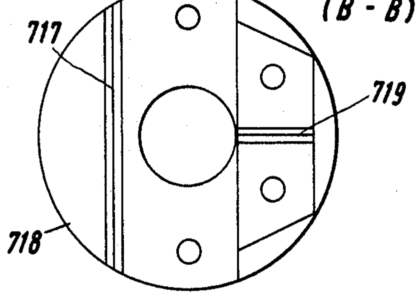


Fig. 8
(C - C)

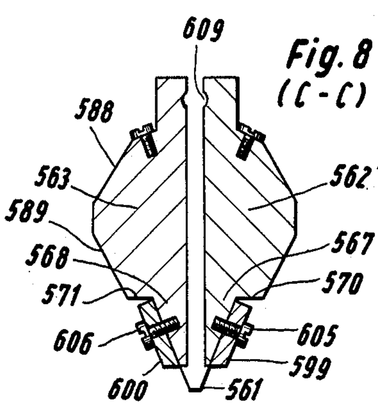
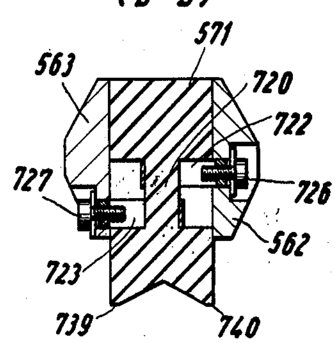


Fig. 11
(D - D)



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REPLACEABLE CATHODE FOR ELECTRON BEAM GENERATING SYSTEM

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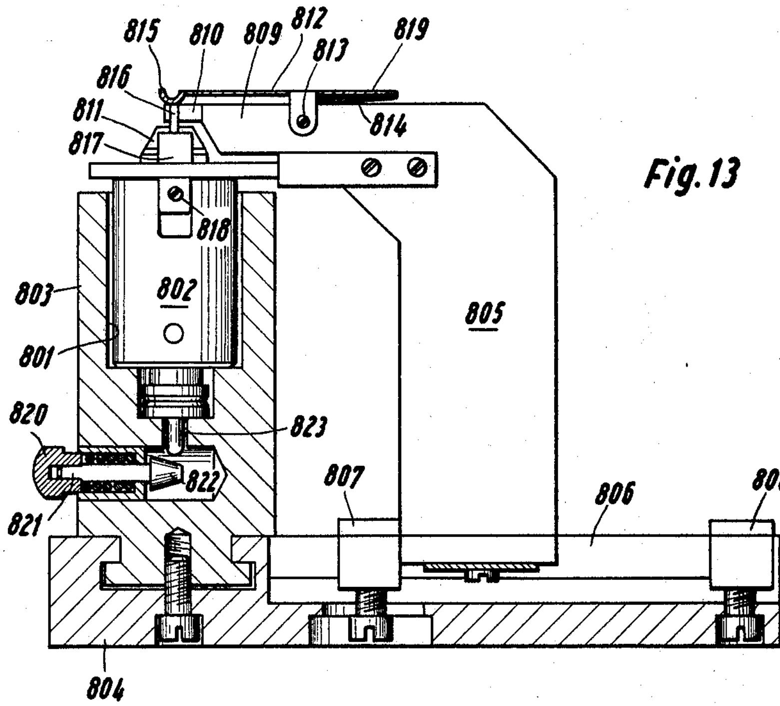

Fig. 13

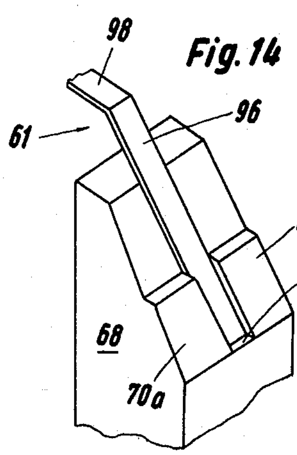

Fig. 14

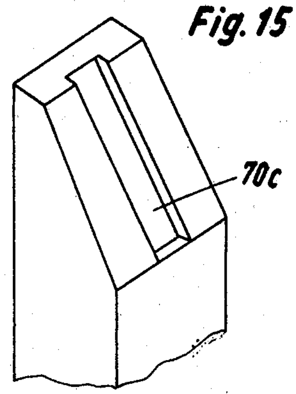

Fig. 15

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Fig. 16

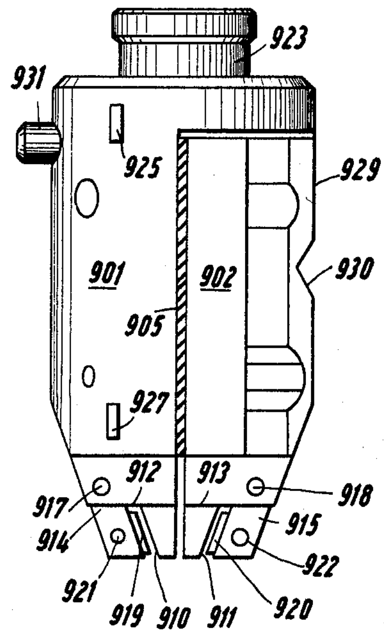

Fig. 17

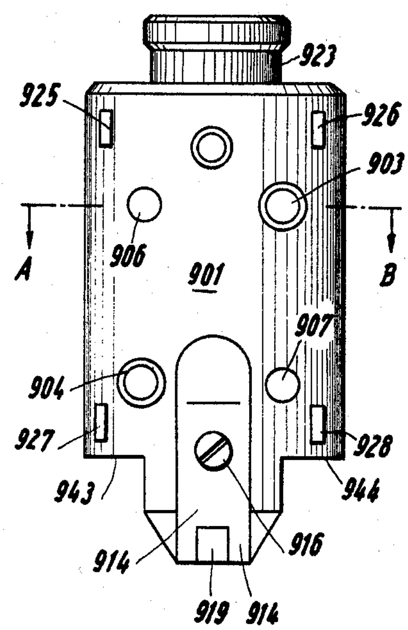

Fig. 18

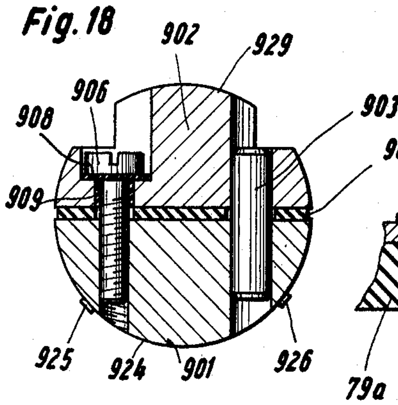

Fig. 20

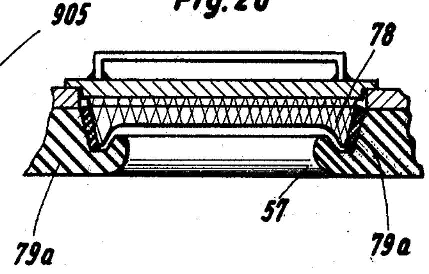

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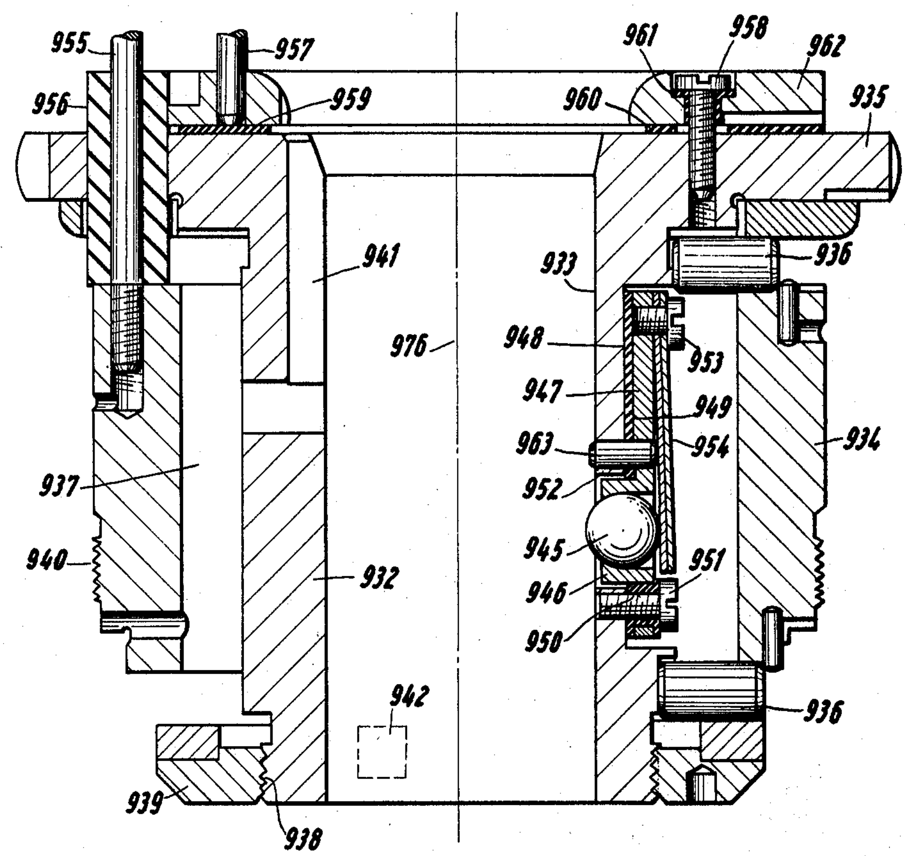
Fig. 19



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3,478,244
REPLACEABLE CATHODE FOR ELECTRON BEAM GENERATING SYSTEM

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Claims priority, application Germany, Dec. 14, 1965, St 24,761
Int. Cl. H01j *1/02, 313/38*
U.S. Cl. 313—237 39 Claims

ABSTRACT OF THE DISCLOSURE

In an electron beam generating system having a replaceable cathode, the Wehnelt cylinder, the anode and the electron optical system are arranged in the housing of the system in fixed positions relative to one another and to the housing. The cathode holder and cathode may be replaced through an opening provided by means of a detachable housing portion, and the cathode holder and cathode are insertable in a mounting which is fixedly located with respect to the Wehnelt electrode and has locating means to impart to the cathode holder and cathode a predetermined operating position relative to the Wehnelt electrode.

The present invention concerns an electron beam generating system having a beam source comprising a replaceable cathode holder and cathode, a Wehnelt electrode and an anode, in which the Wehnelt electrode or a structural part rigidly connected thereto serves as a support for the cathode holder, there being also an electron optical system and an evacuable housing which has a readily detachable housing part enabling the cathode holder and cathode to be changed.

In an electron beam apparatus as used, for example in electron beam welding, cutting and milling machines or the like, the cathode, and the Wehnelt electrode are usually connected to a high negative potential, for example −150 kv. relative to ground, whilst the remaining parts of the installation are connected to ground potential. Since the Wehnelt electrode and the cathode form the starting point of the electron beam, these parts are often combined in known installations to form a beam head. The high tension carrying parts of the beam head are assembled at the inner end of an insulating core projecting into the apparatus housing and high tension leads extend from the outside through insulating cores, usually filled with oil to the electrodes of the beam head by means of sealed in wires. The insulating core may form a disengageable socket connection with the end of a high-tension cable, which connection is preferably formed so as to be shockproof. To enable the cathode to be readily changed in such known electron beam apparatus, the insulating core and the beam head secured thereto are mounted on a readily detachable housing part, which may be hinged, so that after destroying the vacuum in the housing, the readily detachable housing part is released, permitting the cathode to be changed by means of the freely accessible parts of the beam head. Thus, it is not necessary for the flexible high-tension cable to be uncoupled.

It has been proven in practice that in an electron beam apparatus of the kind referred to, the beam has to be readjusted after each cathode change. The reason for this readjustment is that the detachable housing part, which naturally is relatively large, after replacement on the housing and subjection to the influence of forces acting thereon during the subsequent evacuation, does not return exactly to the same position relative to the remaining

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parts of the installation which the housing had before the cathode change. The necessary adjustments require a certain expenditure of time, which constitutes a loss of possible operating time and impairs the economic value of the electron beam apparatus. In addition, there is the fact that owing to the relatively high weight of the beam head and of the detachable housing part, a special lifting tackle usually has to be installed, and difficulties may be encountered in carrying out the work of changing the cathode at the exposed beam head, owing to the restricted spatial conditions at the site of use of the apparatus.

The object of the invention is to provide an electron beam generating system in which the cathode may be changed in a simple manner and in which the loss of operating time involved by the cathode change is substantially minimized.

According to the present invention, in an electron beam generating system of the kind referred, the Wehnelt electrode to the anode and the electron optical system are arranged in the housing with fixed positions relative to one another and to the housing, the support including a mounting for the cathode holder, said mounting being arranged at a fixed relationship with the Wehnelt electrode, and having locating means, which impart to the cathode holder a predetermined operating position relative to the Wehnelt electrode when inserted in the mounting, and the readily detachable housing part is located at a point of the housing in the insertion path of the cathode holder and so dimensioned that the cathode holder may be inserted in the mounting through the opening formed by removal of the readily detachable housing part.

In an electron beam generating system in accordance with the invention the readily detachable housing part no longer supports the beam head and therefore is lighter in weight. It is only necessary, on changing the cathode to remove the said part, whereupon the cathode holder is slid out of its mounting in the Wehnelt electrode and removed from the housing through the housing opening. This may be effected without the aid of special lifting tackle.

Since the cathode holder is then completely separated from the machine, it may be fitted with a new cathode at a work place remote from the machine. The cathode holder may then be reinserted in its mounting through the housing opening. Due to the locating means, an accurate predetermined operating position of the cathode holder and cathode is automatically obtained, so that readjustment of the beam after renewed operation is not necessary. If the current supply to the cathode holder is made via plug contacts, no further operations are required; it is only necessary for the cathode holder to be returned to its mounting. The readily detachable housing part is conveniently and quickly replaceable by hand, due to its light weight and its small dimensions.

The advantages described are of particular significance if it is important to maintain the beam generating parts within close tolerances. Usually, an electron optical system is used in succession to the beam generating system to form the beam. Such electron optical systems are particularly sensitive to variations of adjustment of the beam generating system. The invention is of particular importance in connection with such apparatus.

The described electron beam generating system is such that at least one replacement cathode holder with completely assembled cathode may be kept ready as spare and, if a cathode change becomes necessary, may be changed for the cathode holder in use. With this method of operation the expenditure of time on the actual cathode change is so slight that the period that the machine is out of action is determined mainly by the pumping time required for renewed operation.

Reference should now be made to the accompanying drawings in which:

FIG. 1 is a vertical section on a reduced scale through the upper portion of an electron beam generating system in accordance with the invention;

FIG. 2 is a plan view of the Wehnelt electrode in the direction of the arrow II of FIG. 1. The cathode holder and auxiliary fittings are not shown;

FIG. 3 is a cross-section through the Wehnelt electrode on the line III—III of FIG. 1 without cathode holder and fittings;

FIG. 4 shows on an enlarged scale a vertical section through the lower portion of the Wehnelt electrode with cathode holder inserted, in a view corresponding to FIG. 1.

FIG. 5 shows the apparatus of FIG. 4, but rotated through 90° about a vertical axis;

FIG. 6 is a sectional view on the line VI—VI of FIG. 4;

FIG. 7 is a vertical section through the upper portion of an alternative embodiment of an electron beam generating system;

FIG. 8 shows the cathode holder of FIG. 5 in a section on the line C—C of FIG. 7;

FIG. 9 shows a side view of the cathode holder used in FIG. 7, turned through 90° about the vertical axis relative to FIGS. 5 and 6;

FIG. 10 is a section on the line A—A of FIG. 9;

FIG. 11 is a section on the line D—D of FIG. 9;

FIG. 12 is a plan view of the base plate shown in section at the bottom of FIG. 9;

FIG. 13 is a side view, partly in section, of a gauge device for mounting a cathode on a cathode holder;

FIG. 14 is a perspective view of part of a cathode holder;

FIG. 15 is a perspective view of an alternative form of a cathode supporting member;

FIG. 16 is a side view of an embodiment of a cathode holder in accordance with the invention;

FIG. 17 is a side view of the cathode holder of FIG. 16 turned through 90°;

FIG. 18 is a section on the line A–B of FIG. 17;

FIG. 19 is a vertical section of an embodiment of a socket mounting for the cathode holder shown in FIGS. 17 and 18;

FIG. 20 shows the use of a packing ring.

In FIG. 1 the upper portion of an electron beam generating system in accordance with the invention is shown in vertical section. In a housing generally denoted by **1**, a beam source and an electron optical system are arranged in rigid locational relation to one another. On a mounting plate **2**, which has a flange **3** formed at the edge, an accurately dimensioned insulating tube **5**, is located and secured by means of screws *4a*; the tube is made of ceramic or other suitable material. In the center of the circular mounting **4**, concentrically with the insulating tube **5**, an opening **6** is formed to receive a tubular anode **7**. This anode is secured in the openings by being screwed therein. In the embodiment shown the anode **7** is hollow, with an internal cross-section increasing progressively downwards. Its smallest cross-section is located at the upper end which is protected against peak discharges to the electron source arranged thereabove by means of a radiused corona discharge guard ring **8**. A screen **9** is mounted on the anode tube **7** below the supporting plate **2** with clearance therefrom. In the space between the insulating tube **5** and the anode **7** the mounting plate has several pressure equalising apertures **10** formed therein. The mounting plate **2** also has apertures **11** formed therein outside the insulating tube **5**. At the upper end of the insulating tube **5** the Wehnelt electrode **12** is located and secured by means of a holder **13**. A high-tension insulated lead-in conduit **14** terminates in the proximity of the upper end of the insulting tube **5**, in which the leads for the Wehnelt voltage, the cathode heating voltage and the beam voltage are combined. The lead-in conduit **14** extends into the interior of the housing **1** from an insertion point **15** up to the upper connecting point **16** located in the proximity of the Wehnelt electrode. From the connecting point **16** simple, uninsulated leads **17, 18, 19** lead to the corresponding parts of the beam generating system subject to high-tension; the leads **17** and **18** go to contacts described below for cathode heating, and the lead **19** to the (metal) holder **13** of the Wehnelt electrode **12**. As protection against corona discharges, a radiused corona discharge hood **20** is placed over the high tension carrying parts. The hood has an inwardly bent lower edge which engages in an annular groove **21** of the Wehnelt holder **13** and the metal upper closure **22** of the high-tension insulated lead-in conduit **14**. The Wehnelt holder **13** is secured to the upper portion of the insulating tube **5**, as shown in FIG. **1**, by means of countersunk screws **23** round its circumference. In the embodiment shown in FIG. 1, the point of insertion **15** of the high-tension insulated lead-in conduit **14** is located in an edge section of the mounting plate **2**, and the lead-in conduit **14** extends diagonally from there upwards and inwards.

An upper portion of the housing in the form of a cover hood **24** is mounted on the uper surface of the flange **3** of the assembly plate **2**. The cover **24** is made of insulating material such as ceramic material or synthetic resin. It is mounted partly on the surface of the flange **3** and partly on the surface of an elastic packing ring **26** inserted in the annular groove **25** of the flange **3**. Laterally, the cover **24** is guided by a vertical edge **27** of the flange **3**. The wall thickness and the dimensions of the cover are so selected that any high tension discharge from the upper end of the lead-in conduit **14** and at the corona discharge protective shroud **24** is directed over the outside surface of the housing. The height of the insulating tube **5** and the length of the high-tension insulated lead-in conduit **14** are so selected that a high-tension flash-over from the upper end of the lead-in conduit **14** or the corona discharge protective shroud **20** is prevented. The assembly plate **2** and the anode **7, 8** are connected to earth potential. The cover **24** is enclosed by a metal jacket **28** which is also connected to earth potential and serves mainly to screen any X-rays formed in the apparatus from external objects.

The high-tension insulated lead-in conduit **14** at its point of insertion **15** is vacuum sealed into the housing, by means of elastic packing rings **29** and **30**. The upper connecting end **16** of the lead **14** is also vacuum sealed; the metal closure cap **22** is sealed by means of an elastic packing ring **32** inserted in the upper edge of the outer insulating tube **31** of the lead-in conduit **14** relative to the interior of the insulating sleeve **31** and the leads **17** and **18** for the cathode heating voltage are sealed vacuum tight into the insulated closure cap **22**. Since such sealing techniques are known, the matter is not further dealt with. A further housing part **33**, is mounted vacuum tight on the underside of the flange **3** of the assembly plate **2**. The vacuum seal is an elastic packing ring **34** which is mounted in a groove of the flange **3**. The housing part **33** contains the electron optical system which as shown in FIG. 1 comprises an electromagnetic coil **35**, an annular pole piece **36** with jacket yoke **37**, and a separate annular pole piece **38**. These parts are secured in a predetermined position in the housing part **33** by securing means, not shown in detail. Neither is the securing of the housing part **33** on the flange **3** shown in detail. In FIG. 1 however it is indicated how with the aid of three radial adjusting screws **39** distributed round the circumference of the housing, an alignment means for the mutual radial alignment of the housing part **33** and the flange **3** or the assembly plate **2** is formed. The housing part **33** may form an integral whole with the assembly plate **2** and the flange **3**. In this case, of course, alignment means **39** are not required, but there is no adjustment between the electron optical system and the beam generating system. The housing part **33** and flange **3** may be a sliding fit to provide adjustment.

The current supply to the electromagnetic coil **35** is effected via vacuum tight leads **40** which may also lead outwards at any other point than shown in FIG. 1.

The parts beneath the housing part **33** may be of any desired form and are of no interest so far as the present invention is concerned. They will therefore not be discussed further, and are not shown in the drawings. The pump lines for evacuating the housing are connected to these lower parts. In this connection it is worth mentioning that the relatively long anode tube **7**, the screen **9** and the assembly plate **2** form a screening assembly which prevents evaporated material from a workpiece from being transferred from the lower part of the apparatus into the beam generating system.

The Wehnelt electrode **12** is secured to the insulating tube **5** in an accurately predetermined position by means of its holder **13**. For this purpose the holder may form an integral whole with the Wehnelt electrode, or may be formed as a tight fit therein. In FIG. 1 the upper end of the Wehnelt electrode **12** is provided with an external thread **41** and a rebate **42**, and is screwed into a female thread on the holder **13**. The Wehnelt electrode in the embodiment shown comprises a cylindrical tube **43** having an external thread **45** on its lower end on which a member **44**, which forms part of the actual Wehnelt cylinder, is screwed. The upper end **46** of the tube **43** has an outwardly enlarged wall thickness and an increased mean diameter towards the upper end.

A cathode holder **60** is mounted in the tube **43**, with a cathode **61**. The cathode holder and further auxiliary items have been omitted from FIGS. 2 and 3.

As shown more particularly by the enlarged plan view of FIG. 2 and the cross-section of FIG. 3, the tube **43** is provided with two diametrically opposite axial grooves **47** and **48**, which each have a widened and recessed end section **49** and **50** respectively in the upper end section **46** of the tube **43**. The grooves **47** and **48** do not extend to the lower end of the tube **43**, but terminate in shoulders **51** and **52** respectively (see FIGS. 3 and 5). In one of the grooves, in this case groove **48**, a flat spring **53** extends, the upper end section **54** of which is bent outwards and is secured to the upper end face of the tube **43** with the aid of a screw **55**.

Between the two axial grooves **47** and **48** a further wider axial groove **56** extends, which may also be widened and recessed in the upper end section **46** of the tube **43**. At the lower end this groove **56** extends to the end of the tube **43**, as shown more particularly by FIG. 4.

The cathode holder **60** of FIG. 1 is inserted from above into the tube **43**, until it assumes a predetermined operating position. The tube **43**, which is part of the Wehnelt electrode **12**, forms a socket mounting for the cathode holder **60** which is suitably formed for this purpose.

As shown in FIGS. 1 and 4–6, the cathode holder consists of two substantially parallelopiped metal supporting members **62** and **63** having two apertures **64** and **65** mutually offset in a longitudinal direction of square cross-section, with a longitudinal slot **66** interconnecting these apertures. At their lower end the supporting members **62** and **63** extend into roof-shaped bevelled cathode supporting faces **67** and **68** each of which is limited by a shoulder **69** or **70**. Two rods **71** and **72** extend through the apertures **64** and **65** of both supporting members, the rods being made of insulating material, preferably ceramic material.

In each supporting member a screw **73** or **74** extending across the slot **66** is located in a bore **75**. The part of the bore **75** located on the other side of the slot **66** is threaded to permit adjustment by screwing the screw in this thread for the parts on both sides of the slot **66** of the supporting member to be drawn together. By this means the supporting members are clamped firmly to the rods **71** and **72**. This clamping of the supporting members **62** and **63** enables an accurately predeterminable spatial association of the supporting members and the rods with one another to be obtained. This operation, which is the assembly of the cathode holder, need be carried out only once; during cathode change the joints between supporting members and rods are not disturbed. The supporting members **62** and **63** firmly clamped on the rods **71** and **72** are electrically insulated from one another, since the rods are made of insulating material.

The length of the rods **71** and **72** is such that they may be inserted with slight clearance in the axial grooves **47** and **48** of the tube **43**. The rods and the axial grooves form orientation means adapted to one another which impart a predetermined operating position to the cathode holder **60** inserted in the tube **43** of the Wehnelt electrode **12**.

In the embodiments shown in the figures of the electron beam generating system the cathode holder is inserted from above in the direction of the beam into the Wehnelt electrode. Thus, the axis of the inserting movement and the beam axis coincide. To permit the cathode holder to be removed from its socket mounting in the Wehnelt electrode and to reinsert it in the socket mounting without necessitating the removal of the upper housing portion in form of the shroud **24**, and to permit the removal of the corona discharge protective shroud **20**, there is an opening **77** in the corona discharge protective shroud **20**, and a readily detachable housing part **78** is arranged in the housing at a location lying in the insertion path of the cathode holder which in this case comprises a ground-in stopper. The ground surface **79** is sealed with a high-tension insulating silicon grease. Below the ground surface at least one projecting bead **57** is provided to collect excessive grease. Instead of the ground-in seal, as shown in FIG. 20, a packing by means of an annular member **79*a*** made of high-tension insulating elastomeric material, e.g. silicon rubber, may be provided. The annular member is inserted between the opposite surfaces of the readily detachable housing part and the housing. Since the readily detachable housing part has no fittings or parts of the beam head secured to it, and since the housing part **78** need only be large enough to permit the cathode holder **60** to pass through, the housing part **78** is light in weight and has small dimensions, so that it can be moved conveniently by hand. The guidance of the cathode holder inserted in the Wehnelt electrode solely by the rods **71** and **72** is not sufficient to ensure an accurately reproducable operating position of the cathode holder. It is necessary for the rods **71** and **72** to have a slight clearance in the guide tracks **47** and **48**, to permit the cathode holder to be readily inserted and to prevent excessive mechanical stresses due to temperature increases occurring in operation. Therefore further locating means are provided which locate the cathode holder in two directions at right angles to one another and radially to the axis **76** of the inserting movement and in the inserting direction. In both these directions the cathode holder is acted upon by two spring devices, on the one hand by the flat spring **53**, already described, in one axial groove **48** and on the other hand by two contact springs **80** and **81**, which are fitted on a contact plate **82**, made of insulating material, and arranged in the axial groove **56** with clearance from the inner wall surface of the tube **43**. The plate is secured to the lower end of the tube **43** by means of washers **83** and screws **84** and **85**.

The contact springs **80** and **81**, when the cathode holder is inserted, are supported against the surfaces of the supporting members **62** and **63** opposite the head of the screw **74**, so that one contact spring **80** presses against one supporting member **63** and the other contact spring **81** presses against the other supporting member **62**. This causes the supporting members to be urged away from the contact springs, and the guide rods **71** and **72** are urged against the side surfaces **86** or **87** of the axial guide grooves **47** or **48**. These side surfaces thus act as locating surfaces in the direction of the force action of the contact springs **80** and **81**, whilst in the radial direction normal thereto the central surface of the guide groove **47** opposite the plate spring **53** acts as a locating surface. Finally, the third locating surface in the beam direction consists of the shoulders **51** and **51** forming the end of the axial grooves **47** and **48**. For this purpose the areas of the supporting members **62** and **63** adapted to co-operate with the contact springs **80** and **81** are so formed that the contact springs exert a force component towards the shoulders **51** and **52** on the inserted cathode holder, the surfaces of the supporting members on which the contact springs press, being bevelled. As shown in FIG. 4 the surface engaged by the contact spring **80** comprises a first surface section **88** which, in the direction of the inserting movement, extends obliquely away from the axis of the inserting movement, and a second surface section **89** adjacent therebelow which in the inserting direction, extends obliquely toward the axis of the inserting movement. FIG. 4 shows that the contact spring **80** forms a snap-in device for the cathode holder **60**. With the double contact spring **80** as shown, first the upper portion and then the lower portion of the contact spring **80** is traversed by the hump between the surface sections **88** and **89**, and each time a previously upwardly directed force component reverses and becomes a downwardly directed force component. In the operating position shown in FIG. 4 the contact springs **80** (and **81** not shown) exert a force both to the right and downwardly, directed against the cathode holder. Owing to this, and due to the action of the plate spring **53** shown in FIG. 5, the cathode holder is urged in three directions at right angles against locating surfaces and thus is retained accurately in its operating position.

Other embodiments of spring devices are conceivable which urge the cathode holder in a three dimensional manner against locating surfaces. The embodiment shown is simple inasmuch as the locating springs **80** and **81** simultaneously serve to supply the cathode heating current and the beam current. The current supply to the cathode holder **60** is effected therefore via spring loaded contacts, i.e. the contact springs **80** and **81** which, when the cathode holder is inserted in its socket mounting in the Wehnelt electrode, close automatically. It is obvious that other embodiments of contact springs **80** and **81** than that shown in the figures may be used. In the embodiment as shown in FIG. 4 the bent contact spring is secured by means of two screws **90**, **91**, nuts **92**, **93** and washers **94**, **95** to the contact plate **82**; other methods of mounting are possible such as riveting.

The cathode **61** in the embodiments shown consists of a preformed V-shaped tungsten strip. The shanks **96**, **97** of the V serve as connecting sections and the flat **98** connecting the shanks forms the actual emission surface. As further shown in FIGS. 4 and 5, the cathode **61** is mounted on the cathode bevelled supporting parts **67** and **68** of the supporting members **62** and **63** with its ends supported against the shoulders **70** and **71**. The connecting sections **67** and **68** are clamped firmly in position by clamping levers **99** and **100**. Each of the clamping levers is rotatably mounted in pedestal bearings **101**, **102** by means of bearing pins **103**, **104** and by tightening a clamping screw **105**, **106**, supported against the supporting member **62**, **63**, are pressed against the mounted cathode. Since the two scpporting members are electrically insulated relative to one another and relative to the Wehnelt electrode and are connected to the contact springs **80**, **81**, the cathode is connected electrically to the contact springs **80**, **81**. The connections between the contact springs **80**, **81** and the corresponding wires of the lead-in conduit **14** is effected by means of the leads **17** and **18** (FIG. 1), which pass out via an insulating support **107** and are connected by welding to the central parts of the contact springs **80**, **81** (FIG. 4).

When clamping a preformed cathode **61** to the cathode holder it is important that the cathode is mounted at an accurately determined point of the roof-shaped cathode supporting members **67**, **68**. This may be effected with the aid of a gauge device in which a cathode is kept ready; the gauge is placed on the cathode holder and the cathode is thus mounted in an accurately defined position on the cathode supporting members. A simple form of such a gauge comprises a V-shaped cap-like template which may be fitted accurately on the cathode supporting members having a sliding-fit slot for the cathode so that after the cathode has been clamped firmly in position, the gauge may be pulled off.

FIG. 13 shows such a gauge. This gauge contains a gauge mounting **801** for a cathode holder **802**. The gauge mounting **801** is provided with location means (not shown) which correspond to the location means (not shown) of the cathode holder and which imparts to the cathode holder **802** an accurately predetermined position. The gauge mounting **801** is arranged in a body **803** which is secured in the base frame **804**. The base frame supports a cantilever arm **805** which is displaceable between two stops **807**, **808**. In one end position, at the stop **808**, the protruding portion **809** of the cantilever arm **805** is removed from the insertion path into the gauge mounting **801**, so that a cathode holder which is to be fitted with a cathode, may be inserted in the gauge mounting until it assumes the accurately predetermined position shown in FIG. 13. Then the cantilever arm **805** is slid in to the left up to the stop **807**. A profiled projection **810** located on the cantilever arm and having a cross-section corresponding to the V-shape of a preshaped cathode strip to be inserted, then assumes an accurately predetermined position above the cathode supporting members **811** of the cathode holder **802** located in the gauge mounting **801**. On the protruding portion **809** of the cantilever arm **805** a pressure application lever **812** is rotatably mounted in a bearing **813** and is pretensioned in position by a flat spring **814**, its cranked front end **815** pressing against the projection **810**. At this point a shallow groove is formed in the projection **810** in which a cathode strip **816** is inserted with sliding fit; by depressing the rear end **819** of the pressure application lever **812** the front end **815** of this lever is lifted, the clamping levers **817** of the cathode holder having been lifted off the cathode supporting members **811** by slackening the clamping screws **818**. After insertion of the cathode strip **816** in the shallow groove of the projection **810**, so that its V-shanks assume a position as shown in FIGS. 4, 5, 7 and 8 over the roof-shaped bevelled surfaces of the cathode supporting members, release of the rear end **819** of the pressure application lever **812** causes the front end of the pressure application lever **812** to be pressed against the flat of the cathode strip providing electron emission, so that this flat, the position of which determines the emission centre of the cathode, is retained in an accurately predetermined position relative to the cathode holder. Then by tightening the clamping screws **818** the clamping levers **817** are pressed against the V-shanks of the cathode strip **816**, so that the cathode is clamped firmly in an accurately predetermined position for its central web portion to the cathode holder.

There is a clearance, between the underside of the profile projection **810** and the cathode holder. Below the gauge mounting there is a device for lifting the cathode holder. In the embodiment as shown in FIG. 13 the lifting device has a resiliently displaceable push-button **820** to which a rod **821** with a conical head **822** is secured. The conical head **822**, when the button **820** is depressed, engages with the radiused end of a pin **823**, so that the pin subsequently lifts the cathode holder **802** located on it out of the gauge mounting. After clamping the cathode strip to the cathode holder, the rear end **819** of the pressure application lever **815** is depressed, so that the front end **815** is lifted, then the button **820** is depressed to cause the cathode holder to be lifted and the cathode strip to leave the groove in the projection **810**; then the cantilever arm **805** is pushed away in the direction of the stop **808**, so that the raised cathode holder may be removed from the gauge mounting.

With the gauge mounting described, the position of the emission centre of the cathode is determined by aligning means (projection **810** with groove, pressure application lever **812**), which are independent of dimensional changes which may possibly occur in the cathode supporting member, e.g. in consequence of the heating during operation, so that with each inserted cathode strip the same position of the emission centre is ensured.

Of particular advantage is a gauge device which also effects the forming of the cathode strip and in which the point is adjustable at which the shaped cathode strip is placed on the cathode supporting members of the cathode holder. In a gauge device of this kind, it is further advantageous to ensure proper alignment between the gauge device and the cathode holder by utilizing those parts of the cathode holder as reference elements, which also serve as locating reference elements in actual operation, i.e. here the regions of the rods **71**, **72** which co-operate with the locating side surfaces **86**, **87** of the grooves **47**, **48**. Instead of these it is however also possible to provide guide aids on the cathode supporting members **67** and **68** which cause the cathode to assume the correct position when being mounted. Thus it is possible, for example, to provide, in the portions of the roof-shaped supporting surfaces in the proximity of the shoulders **70**, **71**, two juxtaposed raised portions ***70a***, ***70b***, between which the connecting portion of the pre-shaped cathode may be inserted with a sliding fit, as shown in FIGURE 14. With thick cathode strips it is also possible to provide shallow guide grooves ***70c*** in the roof-shaped supporting surfaces as shown in FIG. 15. Whatever the method adopted, it is understood that the cathode has to be mounted at an accurately defined point relative to the cathode supporting members.

To prevent the portions of the rods **71**, **72** located between the supporting members **62**, **63** from being coated with cathode metal by evaporation, a screen **108** is provided as shown in FIG. 5.

Removal and insertion of the cathode holder is performed with the aid of a key, which is adapted to engage the cathode holder. In the embodiment as shown in FIG. 4 additional openings **109** are formed in the supporting members which may serve as engaging points for a key. The key may be so designed that during the insertion of the cathode holder it also acts as a guide, more particularly when the cathode holder approaches the Wehnelt electrode. The upwardly widened and recessed grooves **47**, **48** (FIG. 2) result in a reliable insertion of the cathode holder. Should the possibility of introducing the cathode holder twisted by error through 180° through the inserting axis should be excluded with absolute reliability, various steps may be taken. For example, the grooves **47** and **48** may be of different widths and the corresponding ends of the guide rods **71** and **72** may vary accordingly in thickness, so that insertion is possible only with the correct orientation. Generally it will suffice however to apply a mark in the proximity of the readily detachable housing part **78** on the housing, which clearly points to the correct position, for example, of the screw heads **74**.

FIGS. 7–12, show an alternative embodiment of an electron beam generating system in accordance with the invention which is particularly suitable for welding machines having a high beam output owing to the cooling measures taken. Hereafter in the description, parts which occur analogous to the embodiment as shown in FIGS. 1–6 are each designated with reference numerals increased by 500; new parts have reference numerals above 700. In contrast to the embodiment as shown in FIG. 1, in the welding apparatus as shown in FIG. 7 the insulating tube **505** supporting the Wehnelt electrode **512** also forms the housing wall. It is thicker than the insulating tube **5** of FIG. 1 so as to present adequate insulation without having additional vacuum spacing. The construction has the advantage that the heat developed by the electron source during operation is readily conducted away. Moreover the dimensions of the housing are reduced.

As evident from FIG. 7 the lower edge of the insulating tube **505** has a metal annular flange **503** secured vacuum-tight thereto. The insulating tube is preferably made of a moulding resin mixed with a mineral filler substance and the flange **503** is connected with the insulating tube during moulding. For this purpose the flange **503** is provided with an anchoring profile **701** which is spherical in radial section, ensuring a secure mounting in the insulating tube **505**.

The inner edge **702** of the flange **503** is a sliding fit, and an outer conical surface **703** of the flange **502** is also a sliding fit. A sealing surface **704** co-operating with surface **703** is formed on the flange **503**, which sealing surface has an elastic annular sealing packing **705** in a lower housing part **533**. The lower housing part **533** has an inner face **706** which forms a sliding fit with the already mentioned outer face **703** of the annular flange **503**. Due to this sliding fit the insulating tube **505** may be removed from the lower housing part and replaced thereon without appreciably altering the geometry of the beam producing parts. The lower housing part **533** as in the embodiment as shown in FIG. 1 assumes a predetermined locational relationship with the electron optical system and the other parts devices of the welding machine. These are not referred to further herein.

The inner face **702** of the flange **502** serves to locate a metal assembly plate **702** having pump openings **510** formed therein, the plate being centrally secured in a similar manner to the tubular anode **507** in FIG. 1, with an anode screen **508** screwed thereon. The sliding fit between the assembly plate **502** and the flange **503** is protected by an upright radiused corona discharge protective collar **707**. The sliding fit at **702** may also be formed as a screw connection.

In the upper portion of the insulating tube near the inner wall surface thereof a supporting ring **708** is anchored as by moulding, the exposed inner edge of which is provided with a thread and a sliding fit **709**, and serves to secure an annular Wehnelt holder **513**. The Wehnelt holder **513** is formed in a conventional manner with radiused edges and contains an annular plate **710** which is pierced by openings **711**. The Wehnelt electrode **512** is integral with the annular plate **710**; alternatively it may be made as a separate component and fitted into the annular plate. Since when changing a cathode the mutual positions of the insulating tube **505**, the anode **507**, the Wehnelt electrode **512** and the lower housing part **533** do not alter, the holding means and location of these parts will not be further described.

In the embodiment as shown in FIG. 7 a cathode holder **560** is used the positioning of which is effected by two knife edge bearings arranged perpendicularly relative to one another which are located in the direct proximity of the cathode. The Wehnelt electrode is formed as a socket mounting for the cathode holder. As in the embodiment shown in FIG. 1, the Wehnelt electrode comprises a tube **543** and a shaped member **544** which forms the actual Wehnelt cylinder, screwed to the tube. In the embodiment shown the tube **543** has an intermediate tube **712** inserted therein with sliding fit, which serves as support for contact mounting plates **582**, ***582a***, of insulating material. The intermediate tube **712** has a radial shoulder **713** as stop for the upper edge of the shaped member **544**, and a sliding fit **545** for the upper lateral edge of the shaped member **544**. A threaded ring **714** is screwed into a recess formed on the lower edge of the intermediate tube **712**. The outwardly protruding upper edge of the shaped member **544** is supported between the shoulder **713** and the threaded ring **714** at the sliding fit **545**. In the upper part of the tube **543** a female thread **715** is formed to receive a threaded ring **716** which in this case presses the intermediate tube **712** with the threaded ring **714** screwed thereon and the upper edge of the shaped member **544** together to form a rigid unit. On the inside surface of the base, closing the shaped member **544** downwardly, there is also secured a washer **717** having a central hole, held in position by means of screws. As shown by the plan view of FIG. 12 and the sectional view in the lower part of FIG. 9, two grooves **718** and **719** for the knife edge bearings **730** and **731** are formed at right angles to one another in the upper surface of this washer **717**.

In the embodiment shown it is not only possible for the cathode holder to be removed, but it is also possible for the parts determining the acceleration field, which are detachably arranged in their seatings, to be removed through the opening **577** in the housing closed by the detachable housing part **578**. This is necessary at intervals for the purpose of cleaning. After slackening the threaded ring **716** and releasing the socket connections **734** the intermediate ring **712** with the parts secured thereto, e.g. the parts **544** and **714**, may be drawn out upwardly. For this purpose a key (not shown) is used which is adapted to engage in grooves or projections (not shown) in the intermediate ring **712**. After removing the intermediate ring **712** and the parts connected thereto it is also possible for the anode screen **508** to be slackened by means of a further key and pulled up through tube **543**. The external diameter of the anode screen **508** is slightly smaller than the smallest free diameter of the tube **543**, and it is also provided with key engaging means, i.e. the grooves **739** indicated in FIG. 7. Even after removal and replacement of the said parts of the acceleration system, the beam geometry of these parts remains unchanged.

The cathode holder comprises two supporting members **562**, **563** electrically insulated from one another, which like the supporting members **62**, **63** of the embodiment shown in FIG. 1 are provided with a first bevel surface **588** and a second bevel surface **589**. At the lower end the supporting members **563** extend into cathode supporting parts **567**, **568** which are provided with roof-shaped bevelled supporting surfaces and shoulders **570**, **571** for the support of the cathode **561**. Instead of the clamping levers of FIG. 1 simple clamp plates **599**, **600** are used, with clamping screws **605**, **606**.

The structure of the cathode holder and more particularly the retention of the two supporting members **562**, **563** is evident from FIGS. 8–12. Between the supporting members **562**, **563** two ceramic material members **571**, **572** are inserted, of which the central sections are tapered into circular cylindrical webs **720**, **721**. The webs are so long that on each web two metal tightening straps, e.g. the straps **722**, **723** are accommodated with mutual clearance. One end of each tightening strap is connected with a supporting member **563** and may be tightened by means of a screw **726–729**. This causes the supporting members **562**, **563** with the ceramic members **571**, **572** to be formed into a unit. The lower ends of the ceramic members **571**, **572** are formed as knife edges at right angles to one another, and fitting the knife edge bearing grooves **718**, **719**. The knife edge bearings and the knife edge bearing grooves form locating means whereby the location of the cathode holder relative to the Wehnelt electrode is accurately reproducable.

As evident from FIG. 7 the contact springs **580**, **581** secured to the contact supporting plates **582**, **582*a*** are so arranged that, when the cathode holder is inserted, they engage with the bevel surfaces **588**, **589** of the supporting members **562**, **563** and in the operating position shown in FIG. 7 they exert a downward force component on the cathode holder in the direction towards the socket mounting. Lead-in wires **517**, **518** for the cathode heating current are connected to the contact springs **580**, **581**.

Since the cathode holder is connected only by its ceramic knife edge bearings and the contact springs **580**, **581** with the Wehnelt electrode and of these connections the contact springs have by far the higher degree of heat conducting ability, substantially the whole heat flow from the cathode holder, is discharged by the supporting members **562**, **563** via the contact springs **580**, **581** and the lead-in wires have to have a large cross-sectional area, promoting heat conduction. To prevent damage to the insulating tube **505** and the other plastics material injection moulding parts it is necessary to ensure that the temperature of the components coming into contact with these members is kept sufficiently low. For this purpose the holders for the lead-in wires and the Wehnelt electrode mounted on the housing or the insulating tube respectively are formed so as to be supported over a large area so that the heat flow is also widely spread.

Accordingly the holding means for the Wehnelt electrode **512**, i.e. the supporting ring **708** is shaped so as to have a relatively large contact surface with the insulating tube **505**, so that local overheating of the insulating tube is prevented. The holding means, more especially the annular Wehnelt holder, act as cooling vanes owing to their large surface. Similar measures for heat dissipation are provided for the lead-in wires **517** and **518**; thus the lead-in wires are each connected to a sector of a ring of cooling vanes **732**, **733**; the connections may be welded or established by means of socket couplings **734**. The lead **519** serving to supply the Wehnelt voltage as shown in FIG. 7 is also connected to a sector of the ring of cooling vanes. In this embodiment three such cooling lugs/vanes in all are provided. These cooling vanes as evident from FIG. 7, are mounted integrally on the inside surface of the insulating tube **505** in contact with the inwardly protruding edge section **524**, and may be moulded or cemented thereto. The heat flow along the leads **517**, **518** and **519** is thus distributed over the whole area of the cooling vanes, so that this temperature remains low enough to avoid any harmful local overheating of the insulating material. At all points the thickness of the insulating layer between the parts connected to high-tension and the outside earthed surface of the housing is so dimensioned that a disruptive puncture is impossible. In the embodiment shown in FIG. 7 the distance between the holders of the hot components and the outside surface of the housing does not include a vacuum gap; rather this distance is completely filled with a layer of an insulating material which is sufficiently thick for the electric insulation and constitutes itself part of the housing.

The metal jacket **735** of the housing provided is supported close against the outer surface of the insulating body and therefore has a good heat conducting contact therewith. This jacket **735** is connected to earth potential. A radiation shield **528** may also be provided. To produce a good heat conducting contact between the radiation shield **528** and the metal enclosure **735** the radiation shield is spaced in a circumferential region located below the beam generating system from the inner housing, by means of an elastic packing ring **736**, and the space **737** between housing **505** and radiation protection enclosure jacket **528** is filled with a good heat conducting medium. Alternatively a cooling fluid such as air or water may be pumped through the space **737**.

Similar steps are taken to insert and remove the cathode holder, in the embodiment as shown in FIG. 7, as in the embodiment of FIG. 1. The central opening **577** defined by the edge section **524** of the insulating tube **505**, and the opening left open in its centre by the sector-shaped cooling vanes **732**, **733** are of such a size as to permit the cathode holder **560** to be passed therethrough without difficulty. The central opening **577** is closed by means of a readily detachable housing part **578** in the form of a ground-in stopper, the ground surfaces **579**, being sealed with a highly insulating silicone grease. Suitable anchoring means are provided on the cathode holder in the form of the opening **609** shown in FIGS. 7, 9, with which a displaceable pin of a key may engage. The upper surface of the housing is covered by a metal screening cover **738** of suitable thickness so that total screening of the beam generating system is obtained.

The connection to the electric supply leads connected to high potential is not shown in FIG. 7. It is obvious that connections extend from the three cooling vanes **732**, **733** to a multi-core high tension connection which passes out of the side of the housing and may be formed as a socket connection.

FIGS. 16–18 show an alternative embodiment of a cathode holder which may be inserted in a socket mounting as shown in FIG. 19. This cathode holder, like the embodiments shown in FIGURES 1 and 7, also comprises two metal supporting members **901** and **902** which are electrically insulated from one another. The cathode holder has a generally cylindrical shape. One supporting member **901** has a cut-out in which the other supporting member **902** is inserted. For mutual alignment two ceramic pins **903** and **904** are used, which are mounted with sliding fit in continuous bores of the supporting members. A ceramic plate **905** is used, for the insulation between the two supporting members. The members are held together by screws **906** and **907**, which are insulated from the supporting member **902** by means of insulating washers **908** and insulating sleeves **909** (FIG. 18). The ceramic plate **905** has holes for the pins **903**, **904** and the screws **906**, **907**. The lower ends of the supporting members are provided with roof-shaped bevelled supporting surfaces **910**, **911** which end in shoulders **912**, **913** and serve to support a V-shaped cathode strip (not shown). To clamp the cathode strip in position as in the embodiment shown in FIG. 5, clamping levers **914**, **915** with clamping screws **916** are provided. The clamping levers are rotatably mounted at **917**, **918**. The lower ends of the clamping levers are recessed and the clamping jaws **919**, **920** are rotatably mounted at **921**, **922**. At the upper end one supporting member **901** is provided with a cylindrical extension **923**, in which a female thread (not shown) is formed to enable the cathode holder to be engaged by a threaded key. On the cylindrical outer surface **924** of the one supporting member **901** projections **925–928** are provided which are vertically and circumferentially offset relative to one another. In the outer surface **929** of the other supporting member **902** a horizontally extending V-slot **930** is formed at a point located substantially symmetrically to the projections **925–928** of the supporting member **901**. A protruding guide projection **931** is also formed on the supporting member **901**.

The cathode holder shown in FIGS. 16–18 is associated with the Wehnelt arrangement shown in FIG. 19. This arrangement comprises an internal member **932** having a cylindrical continuous bore **933** enlarged at the upper end and a tubular outer body **934** rigidly connected with the internal member and electrically insulated from it. The Wehnelt arrangement shown in FIG. 19 is secured as shown in FIGS. 1 and 7, to the structure of the apparatus, and both the outer member **934** and the inner member **932** may be formed as fixing means. In the arrangement shown in FIG. 19 the inner member **932** is provided at its upper end with an annular flange **935** serving as a mounting. The relative positions of inner and outer members is determined by ceramic pins **936** distributed over the circumference. In the annular space **937** between inner and outer members, axially parallel ceramic spacer rods may also be provided. As shown in FIG. 19, the whole assembly is held together by a ring **939** screwed to the lower end of the inner member at **938**. On the outer circumference of the outer member **934** a thread **940** is provided, serving to screw on a Wehnelt assembly (not shown), which is shaped as the Wehnelt member shown in FIGS. 1 and 7, or at **544**.

In the inner wall surface of the inner body **932** an axial groove **941** extending substantially to the centre of the inner member is formed, which when the cathode holder is inserted, receives the guide projection **931** and thereby ensures the correct angular positioning of the inner member and cathode holder. The correct position of the cathode holder in an axial direction is determined by the projections **942** formed in the inner wall surface of the inner member. These projections engage with the shoulders **943**, **944** (FIG. 17) of the supporting member **901** of the cathode holder. Centering of the cathode holder in the inner member is obtained by means of a resiliently mounted ball **945** in the wall of the inner member which presses the inserted cathode holder in the direction of the opposite wall, so that the projections **925–928** (FIGS. 16–18) are in engagement with this wall region. The ball **945** is insulated from the inner member. As shown in FIG. 19, the ball **945** is mounted in a seating **946** on a supporting plate **947**, which is secured in a channel **948** formed in the outer wall of the inner member **932**; the plate **947** is insulated by insulating material **949**, **950** and fixed by means of screws **951**. The accurate positioning of the supporting plate **947** is ensured by means of a ceramic locating pin **963**. The seating **946** with the ball **945** engages with clearance in an aperture **952** of the inner member. On the supporting plate **947** a spring assembly **954**, with two flat springs is secured by means of screws **953**; this spring assembly urges the ball **945** inwardly in the bore of the inner member. The ball **945** and the V-slot **930** together form a stop device which retains the cathode holder in the centered end position when inserted in the inner member.

The inserted cathode holder and supporting member **901** are electrically connected by way of the projections **925–928** with the inner member **932**, whilst the other supporting member **902** is only in connection with the ball **945**.

To ensure that the cathode heating current (and the beam current) is reliably supplied, pressure contacts in the form of resilient contact springs (not shown) are provided, which are so arranged in the wall of the inner member **932** that, when the cathode holder is inserted, they come into contact with the supporting members **901** and **902**.

In the Wehnelt arrangement shown in FIG. 19 the Wehnelt voltage is supplied to the outer member **934** via a contact pin **955**. The contact pin **955** is passed through an insulating member **965**. Contact pins may also be provided to supply the cathode heating current (and the beam current); in FIG. 19 such a contact pin **957** is shown, which is inserted in an annular plate **962** secured and electrically insulated by means of screws **958** and insulating material **959**, **960** and **961** to the inner member flange **935**. The annular plate **962** is connected by means of a lead (not shown) with a contact spring (not shown) which is supported against the supporting member **902** of the cathode holder. A further contact pin (not shown) may be provided, which is in direct connection with the inner member and the other contact lugs.

As evident from FIGS. 16–19, the Wehnelt arrangement shown therein, which is not moved during cathode change and which remains in a fixed position relative to the electron optical system of the beam, also forms a socket mounting for an interchangeable cathode holder. A cathode holder inserted in the socket mounting, i.e. the inner tube **935** rigidly connected to the Wehnelt electrode screwed on to the outer tube **934** has an accurately predetermined operating position relative to the Wehnelt electrode, established by the projections **925–928**, the projection **942**, the guide projection **931** and the guide track **941**. These elements act as locating means. The spring device **954** operating with the ball **945** causes the cathode holder to be radially urged in position and thus the position of the cathode holder relative to the beam axis **976** is determined.

Numerous other embodiments are possible without departing from the scope of the invention. Thus instead of the knife edge mounting shown in FIGS. 7–12, a three-point mounting may be provided; it is also possible for the parts not displaced during a cathode change to be formed so as to be detachable, and mounted in close tolerance holders to permit the apparatus to be dismantled lithout interfering with the structural geometry.

We claim:

1. An electron beam generating apparatus comprising a cathode electrode, a cathode holder to support the cathode, a Wehnelt electrode and an anode electrode, with said electrodes arranged to generate an electron beam along an axis,
  - a support mounting on the Wehnelt electrode to slidingly and removably support the cathode holder with predetermined locating of the cathode relative to the operative region of the Wehnelt electrode,
  - an evacuatable housing enclosing said electrodes and having a readily detachable housing part for axial removal and axial insertion of the cathode and cathode holder through an opening in the housing formed by removal of the detachable part without physical disturbance of high voltage conductors applied to the Wehnelt electrode.

2. The apparatus according to claim 1 wherein the readily detachable housing part is provided with an electrically insulating material facing the cathode, and wherein said housing is lined with an insulating material on the internal surface thereof, with peripheral facing surfaces of the insulating material of the detachable part and the housing internal surface shaped to provide an insulating distance for high-tension insulation from the cathode.

3. The apparatus according to claim 2, in which a high tension insulating paste-like sealing agent is used for vacuum sealing the readily detachable housing part to the housing.

4. The apparatus according to claim 1 wherein the cathode holder is insertable in the supporting mounting in the direction of the beam.

5. The apparatus according to claim 1 wherein the Wehnelt electrode is provided with a guide track, and the cathode holder is provided with a guide member sized to fit within the guide track with close slidable clearance, a spring attached to the Wehnelt electrode to urge the cathode holder into a desired radial position relative to the beam axis.

6. The apparatus according to claim 5 wherein several springs are provided angularly offset relative to one another about the beam axis of the inserting movement of the cathode holder.

7. The apparatus according to claim 6, wherein said Wehnelt electrode is provided with two substantially parallel and diametrically opposite axial guide tracks along the axis of the inserting movement of the cathode holder, with one of the springs arranged in one of the guide tracks to locate the inserted cathode holder against the other guide track.

8. The apparatus according to claim 5 wherein a region of the cathode holder cooperating with the spring is so formed to establish a force component in the beam axis direction against the inserted cathode holder.

9. The apparatus according to claim 8, wherein said one cathode holder region is a bevelled surface spaced from and aligned obliquely to extend away from the axis of the inserting movement.

10. The apparatus according to claim 8 wherein said one cathode holder region comprises a first surface section arranged obliquely relative to the beam axis and spaced from the axis for normal operating contact with the spring and wherein said cathode holder is provided with a second cathode supporting surface section disposed obliquely towards the beam axis.

11. The apparatus according to claim 1 wherein said cathode holder fits with snap-in action to the Wehnelt electrode.

12. The apparatus according to claim 10 wherein the Wehnelt electrode and the cathode holder cooperate to form a snap-in connector formed of a radially compressible spring insulatively attached to the Wehnelt electrode and a downwardly slanted surface on the cathode holder in contact with the spring.

13. The apparatus according to claim 1 and further including spring means for conducting heating current to the cathode holder upon the closing of spring contacts when the cathode holder is inserted in the support mounting in the Wehnelt electrode.

14. The apparatus as recited in claim 13 wherein said cathode holder further includes a pair of insulatively spaced electrically conducting cathode supporting members located with the beam axis between them, a pair of radially compressible springs insulatively mounted within the Wehnelt electrode in compressive relationship with the cathode supporting members and means for conducting high voltage electrical power to said cathode members through said springs.

15. The apparatus according to claim 14 wherein the cathode is selectively preformed and is provided with connecting sections clamped firmly on the cathode supporting members of the cathode holder.

16. The apparatus according to claim 15 wherein the cathode supporting members, have a shape adapted to the selected form of the cathode connecting sections and guide means provided on the cathode supporting members for selectively positioning the cathode when secured to the cathode supporting members.

17. The apparatus according to claim 16, in which the guide means include grooves for receiving at least a part of the connecting sections of the cathode.

18. The apparatus according to claim 17 in which the cathode locating means provides a three-point mounting of the cathode.

19. The apparatus according to claim 17, in which the cathode locating means includes two knife edge bearings extending in a plane normal to the beam and spaced from one another at angular positions around the beam axis.

20. The apparatus according to claim 19, in which the cathode holder includes anchoring means for inserting and extracting of the holder by a key.

21. The apparatus according to claim 20, in which the locating means is positioned in the vicinity of the cathode.

22. The apparatus according to claim 1 in a high-tension insulated lead-in conduit extending into the interior of the evacuable housing from a lead-in point to a connecting point located in the proximity of the Wehnelt electrode, the connecting point having adequate clearance relative to the parts of the housing connected to earth potential, and high-tension carrying leads, from the connecting point being connected from the conduit connecting point to the cathode holder and Wehnelt electrode.

23. The apparatus according to claim 22 and further including an insulating tube, with the Wehnelt electrode positioned therewithin, an assembly plate connected to the housing and ground potential for supporting the conduit, the insulator tube and the anode, said assembly plate further being provided with an aperture opposite said conduit.

24. The apparatus as recited in claim 23 wherein the Wehnelt electrode, the anode, the cathode holder and the cathode have a predetermined reproducible position relative to the supporting plate for accurate locating of the cathode with respect thereto.

25. The apparatus according to claim 23, wherein the housing is further provided with a vacuum-tight shroud mounted on one side of the assembly plate.

26. The apparatus according to claim 25, wherein the housing has a vacuum-tight removably mounted housing part located in general alignment with the electron beam.

27. The apparatus according to claim 26, in which alignment means are provided between the assembly plate and the housing part mounted on the other side of the assembly plate for generally aligning the housing part with the electron beam.

28. The apparatus according to claim 27, in which the alignment means has three angularly spaced adjusting screws located substantially radially relative to the electron beam.

29. The apparatus according to claim 27, in which said aligning means includes a sliding fit between two surfaces.

30. The apparatus according to claim 23 and further including holding means for retaining the Wehnelt electrode to the insulator tube, said holding means having a contact surface with the insulating tube sized to prevent local overheating of the insulating tube due to the flow of heat from the Wehnelt electrode.

31. The apparatus according to claim 30, in which the holding means includes cooling vanes.

32. The apparatus according to claim 31, in which said cooling vanes are connected to the high tension lead-in wires for the cathode holder.

33. The apparatus according to claim 31 and further including a layer of high tension insulation connected to an outer ground potential region of the housing, wherein said vanes are connected to said layer of high tension insulation over a surface area selected to prevent overheating from heat conducted by the vanes.

34. The apparatus according to claim 33, in which the housing comprises an inner insulating member and an outer metal enclosure, with said outer enclosure being in good heat-conducting relationship with the inner insulating layer of high tension insulating material.

35. An electron beam generating apparatus comprising

an evacuatable housing,

means attached to the housing for generating a beam of electrons and directing said beam along an axis, said means including a replaceable slidingly mounted cathode,

means attached to the housing for conducting high voltage electrical power to the beam generating means from a location radially removed from the electron beam axis,

said housing being selectively removable to provide access to the replaceable cathode for axial installation and axial removal thereof without physical disturbance of said high voltage conducting means.

36. The apparatus as recited in claim 35 wherein said housing is provided with a replaceable cover over a housing opening sized for passage of the replaceable cathode, said cover and opening being positioned on the housing at a location selected to permit cathode removal without physical disturbance of said high voltage conducting means.

37. The device as recited in claim 35 wherein the replaceable cover is located on the housing in general alignment with the beam axis.

38. The device as recited in claim 37 wherein the beam generating means further includes

an anode, a cylindrical Wehnelt electrode with the replaceable cathode mounted within the Wehnelt electrode and

means for insulatively mounting said cathode with predetermined axial position and angular rotation relative to the beam axis in the Wehnelt electrode.

39. The device as recited in claim 38 wherein the conducting means frictionaly engages the replaceable cathode with a force having a component along the beam axis to axially firmly seat the replaceable cathode on the Wehnelt electrode.

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